



⑪ Publication number : **0 448 755 B1**

⑫ **EUROPEAN PATENT SPECIFICATION**

④⑤ Date of publication of patent specification :
03.05.95 Bulletin 95/18

⑤① Int. Cl.⁸ : **G01R 31/36**

②① Application number : **90105870.1**



②② Date of filing : **28.03.90** *h. a. !*

⑤④ **Intelligent battery system.**

④③ Date of publication of application :
02.10.91 Bulletin 91/40

⑦③ Proprietor : **Anton/Bauer, Inc.**
One Controls Drive
P.O. Box 616
Shelton Connecticut 06484 (US)

④⑤ Publication of the grant of the patent :
03.05.95 Bulletin 95/18

⑦② Inventor : **Bauer, George W.**
1450 Crescent Lake Drive
Windermere, Florida 32786 (US)
Inventor : **Sokira, Thomas J.**
69 Manor Drive
Cheshire, Connecticut 06410 (US)

⑧④ Designated Contracting States :
AT BE CH DE DK ES FR GB GR IT LI LU NL SE

⑤⑥ References cited :
US-A- 4 254 475
US-A- 4 289 836
US-A- 4 352 067
US-A- 4 390 841
US-A- 4 455 523
IBM TECHNICAL DISCLOSURE BULLETIN.
vol. 29, no. 9, February 1987, NEW YORK
USpages 4122 - 4124; "System power savings
by automatic sleep mode"

⑦④ Representative : **Gaucherand, Michel**
Ixas Conseil
15 Rue Emile Zola
F-69002 Lyon (FR)

Note : Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid (Art. 99(1) European patent convention).

Description

BACKGROUND OF THE INVENTION

The invention relates generally to intelligent battery systems comprising a battery pack with electronic circuitry to monitor battery parameters, and an associated battery charger. The invention deals more particularly with apparatus and processes for minimizing power dissipation by the electronic circuitry, and providing two-way communication between the battery pack and the battery charger.

A previously known battery pack with a microprocessor was disclosed in U.S. Patent No. 4,289,836 to Lemelson. The microprocessor monitors battery parameters such as the state of battery charge, number of charging cycles, battery temperature, and battery pressure. The microprocessor may also be used to control a display for the battery parameters. The battery pack is coupled to a simple power supply for recharging purposes. Said system is strictly a one way device where information flows outwardly from the source.

Another previously known battery pack is disclosed in U.S. Patent No. 4,553,081 to Koenck which battery pack includes a microprocessor secured to a battery housing. The microprocessor monitors battery operation to determine remaining battery capacity, and counts the number of shallow discharges and successive recharging cycles to estimate deterioration of the battery. Circuitry within the battery pack occasionally causes a discharge of the battery to determine present battery capacity. The microprocessor and other circuitry require little operating power so that the shelf-life of the battery pack is long. The microprocessor is also coupled to a display for indicating battery capacity and other information obtained from the battery.

The battery pack of U.S. Patent No. 4,553,081 also includes several I/O ports to communicate with a portable computer terminal device and a battery charger.

A general object of the present invention is to provide a battery pack which includes electronic circuitry to monitor battery parameters, which electronic circuitry draws minimal average power.

Another general object of the present invention is to provide a battery pack of the foregoing type and an associated battery charger which can provide two way communication between each other via a small number of interconnections.

A more specific object of the present invention is to provide a battery pack of the foregoing type which accurately monitors battery discharge and charge.

SUMMARY OF THE INVENTION

The invention resides in an intelligent battery

system which monitors battery parameters such as the state of charge of the battery, the temperature of the battery cells and the type of battery. A battery pack within the system comprises positive and negative terminals serially coupled to the battery cells. The positive terminal is adapted to output load current and receive charging current.

According to one feature of the invention, pulses of data current are input to the positive terminal of the battery pack by a battery charger or other device, and the battery pack senses the current pulses. The battery pack includes a memory which stores battery parameter data, and a processor which transmits the battery data to an output port of the battery pack in response to the pulses of data current input through the positive terminal. Alternately, the processor means transmits the battery parameter data to the charger at the onset of the delivery of charging current.

It is preferred that the processor means is rendered into a functional, relatively high power consumption mode, either by a timer or by sensing current flow, to determine the state of charge of the battery cells based on the amount of current flowing through the battery cells. The processor means is rendered into a non-functional, relatively low power consumption mode at other times to conserve power.

BRIEF DESCRIPTION OF THE FIGURES

FIGURE 1 is a simplified circuit diagram of a battery pack and an associated battery charger in accordance with the present invention.

FIGURE 2 is a more detailed circuit diagram of the battery pack of FIGURE 1.

FIGURE 3 is a timing diagram illustrating digital communication between the battery charger and battery pack of FIGURE 1.

FIGURE 4 is a schematic circuit diagram of an amplifier within the battery pack.

FIGURE 5 is a flow chart illustrating operation of a microprocessor and the other electronic circuitry of FIGURE 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the figures in detail wherein like reference numerals indicate like elements throughout the several views, FIGURE 1 illustrates a battery pack generally designated 10 and an associated battery charger 11 embodying the present invention in simplified schematic form. The battery pack includes a plurality of rechargeable battery cells 12 and, by way of example, there are ten to twelve such cells of the nickel cadmium type. Collectively, the battery cells may have a capacity of either two ampere-hours or four ampere-hours. The battery pack 10 further in-

cludes a positive terminal 14 and a negative or return terminal 16 to receive charging current from and return charging current to battery charger 11. The positive terminal 14 also can deliver current to a load (not shown).

When the battery cells 12 deliver current to the load, the current flows in the direction indicated by an arrow 18. Conversely, when the battery cells are charged, current flows in the direction indicated by an arrow 19. Either current develops a voltage across a resistor 20 which is connected in series with the battery terminals and cells. To minimize power dissipation in the resistor 20, the resistor is small, for example, 0.025 ohms.

Battery pack 10 further includes electronic circuitry 21 illustrated in more detail in FIGURE 2. A differential amplifier 22 has inputs connected across the resistor 20 to sense the instantaneous charge or discharge current. The output of the amplifier 22 is applied through a switch 23 and a buffer amplifier 25 to the input of an A/D converter 31 within a CPU 28. As described in more detail below, the CPU reads the output of the A/D converter to determine the state of charge of the battery cells based on the measured charge and discharge currents.

In order to minimize power dissipation by the electronic circuitry 21, the CPU 28 is a type which is capable of entering into a non-functional "light-sleep" mode in which power is disconnected from most of the electronic circuitry within the CPU 28 and the CPU cannot monitor battery parameters. Motorola Model MC68HC11 is such a type. The CPU is programmed to enter into the light-sleep mode when there is neither charging nor discharging activity for a predetermined period, for example, one hour. A timer 101 within the CPU, which may comprise a register incremented with the passage of time, measures the inactive time as described in more detail below. The CPU 28 includes a non-volatile RAM 60 which stores battery parameter data indicating the amount of discharge of the battery cells 12, the number of discharge and recharging cycles, the highest temperature that either the battery cells or the battery system 10 has ever experienced, and the type and serial number of the battery. During the light-sleep, power is supplied to a timer 62 external to the CPU which periodically "wakes-up" the entire CPU to its functional mode to monitor battery parameters. By way of example, the timer 62 wakes-up the CPU every 250 milliseconds to enable the CPU to read the output of the A/D converter 31 to determine the amount of instantaneous charge or discharge current, if any. If amplifier 22 indicates battery discharge, the CPU approximates the ampere-hour discharge during the previous 250 millisecond interval. By way of example, to estimate the amount of discharge between the readings, the CPU may multiply the discharge current times 250 milliseconds. Then, the CPU calculates the remaining charge

in the battery cells 12 by subtracting the amount of discharge between the readings from the battery charge calculated at the previous reading.

When awake, the CPU also monitors the temperature of the battery cells by commanding selection decoder 61 via lines 63 to activate a switch 65 coupled to temperature sensor 67 so that the signal provided by temperature sensor 67 is supplied to the input of buffer 25. Simultaneously, the CPU directs the decoder 61 to disable switch 23 via gate 73. The CPU then reads the temperature from the A/D converter. Next, the CPU activates switch 75 by appropriate commands on lines 63 to interconnect battery pack, surface temperature sensor 77 to the input of buffer 25 while simultaneously disabling switches 23 and 65. Next, the CPU enables switch 79 to interconnect the positive terminal 14 of the battery pack via a voltage divider 81 to the input of buffer 25 while disabling the other switches so that the CPU can monitor the combined voltage of the battery cells. Then, the CPU activates a switch 87 to interconnect a voltage tap 85, which sensors the voltage of half of the battery cells, to the buffer 25 via a voltage divider 89 while disabling the other switches.

During the light-sleep and functional modes of operation, power is supplied to the CPU via a switch 68 and a buffer amplifier 69. The CPU continuously repeats the foregoing cycles of light-sleep and periodic awakening until either the CPU detects charging or discharging activity, or the cell voltage drops below a predetermined level. If the voltage drops below this low level, the CPU 28 transmits a reset pulse to a latch 66 which opens the switch 68 and thereby prevents the delivery of power to the CPU 28. Consequently, the CPU enters into a "deep-sleep" mode. By way of example, during light-sleep the CPU draws approximately 20% of the power that it draws during the functional, "awake" mode, and during "deep-sleep", the CPU draws essentially no power. However, as noted above, during deep-sleep, the data is retained in the non-volatile RAM 60.

During the light-sleep and deep-sleep modes, power is still applied to the amplifier 22 and to comparators 70 and 72, which amplifier and comparators are capable of awakening the CPU from either deep-sleep or light-sleep during charging or discharging. An input of each of the comparators is connected to the output of the amplifier 22. The other, negative input of comparator 70 is provided with a threshold voltage determined by the magnitude of resistors 74 and 76 in relation to the magnitude of resistor 78. The other, positive input of comparator 72 is provided with a threshold voltage determined by the magnitude of resistor 76 in relation to the magnitudes of resistors 74 and 78.

When the battery system is connected to a load, a voltage develops across the resistor 20. The voltage is sensed by the amplifier 22 and applied to the com-

parator 70. If the voltage is above the threshold level, comparator 70 transmits a binary 1 set signal to the latch 66 via OR gate 80. This resumes the supply of power to CPU 28 if it was in deep-sleep. Comparator 70 also transmits a binary 1 signal to interrupt port 83 of the CPU via OR gates 82 and 84. This awakens the CPU from light-sleep if it was in light-sleep and directs the CPU to read the A/D converter and thus, the discharge current. The CPU remains in the functional, awake mode for a predetermined period in which it continuously monitors the discharge. After the predetermined period which, for example, is one hour after the cessation of discharge, the CPU returns to the light-sleep and periodic awakening mode in which timer 62 is used to awaken the CPU. One reason that both the timer 62 and the comparator 82 are used to awaken the CPU from light-sleep is that the comparator is preferably a CMOS or other low power type and may not be sensitive to small discharge currents while the amplifier 22 is sensitive and the timed awakening is useful to monitor such small discharge.

The battery charger 11 includes a source 92 of voltage and an electronic switch 94 which couples the voltage source 92 to the positive terminal 14 of the battery pack. Thus, when the battery charger delivers current to the positive terminal 14, current flows into battery cells 12 and across the resistor 20 in the direction indicated by arrow 19 as noted above. A corresponding voltage is developed across the input of amplifier 22 and comparator 72. This voltage is greater than the threshold voltage of comparator 72 so that the comparator supplies a binary 1 set pulse to latch 66 via OR gate 80 which resumes the supply of power to CPU 28 (if it was in deep-sleep) via switch 68 and buffer 69. The comparator 72 also supplies a binary 1 signal to interrupt port 83 via OR gates 82 and 84. As noted above, the signal applied to interrupt port 83 awakens the CPU from light-sleep if it was in light-sleep and directs the CPU to read the A/D converter. Comparator 72 also outputs to a serial data input port 99 via OR gate 101', and if the A/D converter indicates that the battery is receiving current in the polarity of charge, the CPU reads the serial data input port 99.

As illustrated in FIGURE 3, when the battery pack 10 is installed in battery charger 11, the battery charger can transmit a code 102 to the CPU requesting specific battery parameter data by delivering current pulses 104 into the positive terminal 14. The current pulses cause voltage pulses to develop across the resistor 20 and at the outputs of amplifier 22 and comparator 72. These voltage pulses, as noted above, are supplied to the serial data input port 99 of the CPU. Thus, CPU 28 is awakened by the onset of the first pulse 104 of code 102 by setting of latch 66 (if necessary) and activation of interrupt port 80, and alerted to read the subsequent data. By way of example, the code 102 includes a start bit, a stop bit, and 8 intervening data bits specifying the requested bat-

tery parameter data. Code 102 instructs the CPU to transmit battery parameter data to the logic and microprocessor circuitry 96 within battery charger 11. This data is the data contained within the non-volatile RAM 60 and, as noted above, includes the amount of discharge of the battery, the battery capacity, the number of charging/recharging cycles, the highest battery cell or surface temperature that the battery has experienced, the type of battery, and the serial number of the battery. The CPU transmits the requested information by outputting serial data pulses 108 from output port 120 and through FET buffer 122 and battery pack port 124. The data is received by the charger at input port 126. Then the battery charger 11 may request additional information by transmitting the respective code into the positive terminal 14.

The CPU is also programmed to transmit all of its battery parameter data to output port 124 in a predetermined order after the onset of receipt of charge current 127 if no specific data request current is received.

After the battery charger receives all the data it requires, it charges the battery cells 12 by delivering charging current to the positive terminal 14 in accordance with the state of charge of the battery cell 12, the type of battery, and the temperatures of the cells and battery pack surface. For example, if the battery is substantially discharged and within a safe charging temperature range, charger 11 supplies a maximum charging current. However, if the battery is nearly fully charged or above the temperature range, then charger 11 supplies a lesser current. Charging techniques suitable for the battery pack 10 and battery charger 11 are described in commonly assigned U.S. Patent Application Serial No. 115,155 entitled "Battery Charging System" filed October 30, 1987 by George W. Bauer et al, and U.S. Patent No. 4,554,500 to Sokira issued November 19, 1985.

It should be appreciated that the positive terminal 14 serves to route operating current from the battery cells to an actual load, route data from battery charger 11 to the CPU, and route charging current from the battery charger to the battery cells.

During charging of the battery pack 10, the CPU is continuously awake and functional to accurately monitor the charging current.

Electronic circuitry 21 further includes a communication link 130 comprising a zener diode 132, input resistors 134 and 136 and transistor 137 which link receives data at port 124 and transmits it to the serial data input port 99 of the CPU via OR gate 101. This communication link may be used at the factory or during service to transmit a code to the CPU to elicit data via FET 122. However, battery charger 11 and other types of battery chargers may not be equipped to transmit data to the CPU via port 124 and communication link 130 so that transmission of a data request into terminal 14 either by a specific data code or by

the onset of charging current is important.

The battery pack 10 further includes an LCD bar graph 140 which receives information from the CPU via lines 142 indicating the amount of charge remaining in the battery, and displays this information. The CPU also outputs via line 144, an analog signal, representing the remaining charge in the battery, through a switch 146 to a sample and hold circuit 148. The analog output is provided on port 150 of the battery pack to supply an optional meter within a video camera or other appliance. The output of the sample and hold circuit 148 is also fed back to the A/D converter for calibration purposes.

FIGURES 5(a) and 5(b) form a flow chart illustrating the operation of the CPU and associated circuitry. To begin the operation, the system is powered-up by the application of power to the CPU (step 200) by setting of latch 66 as noted above. Then, the CPU starts the timer 62 (step 202) by transmitting a pulse on line 205 and enters into the non-functional, light-sleep mode (step 203). Next, a pulse is applied to interrupt port 83 either by the timer, comparator 70 or comparator 72 (step 204). As noted above, comparator 70 transmits such a pulse to interrupt port 83 upon discharge of the battery and comparator 72 transmits such a pulse to interrupt port 83 upon charge of the battery. After any of the three events, the CPU awakens from the light or deep-sleep, reads the temperature sensors 67 and 77, the full battery voltage, and the half battery voltage to determine if the battery is within safe operating limits (steps 206 and 208). Next, the CPU reads the charge or discharge current by reading A/D converter 31 (step 210). If no current is flowing at the time, the CPU determines whether the overall battery voltage is less than the low, cut-off level which represents the specified usable limit of the battery pack (step 214). If the battery voltage is below this level, the CPU transmits a reset pulse on line 215 to latch 66 to power-down the CPU. If not, the CPU loops back to step 202 to start the timer again.

Returning to step 212, if current was flowing at the time, the CPU determines whether the current is in the charge or discharge mode (step 218) by reading the output of the A/D converter. If in the charge mode, the CPU proceeds to step 220 in which it determines whether data is being transmitted into terminal 14. If so, the CPU reads the data (step 227) and in response, transmits the requested information via output port 124 (step 224). If, on the other hand, the charging current was simply charging current and did not contain variable data, the CPU proceeds from step 220 to step 226 in which it transmits all relevant data in a predetermined order to output port 124. After the transmission of data in either step 224 or step 226, the CPU calculates the amount of charge of the battery pack (step 230).

Returning again to step 218, if amplifier 22 indicates that the battery is being discharged instead of

charged, step 218 leads to step 232 in which the CPU calculates the amount of discharge of the battery cells (step 232).

After either of steps 230 or 232, the CPU updates the LCD display 140 and the sample and hold circuit 148 with the current state of charge of the battery (step 234).

Next, the CPU again monitors the temperature sensors 67 and 77 and the full battery voltage and half battery voltage (steps 236 and 238). The CPU also stores data indicating the extreme temperatures and voltages to which the battery pack has been exposed (step 240). Then, the CPU resets the timer 101 (step 241).

Next, the CPU reads the output of A/D converter 31 to determine if there is additional current flowing through the battery cells (step 242), and if so, loops back to the step 218 to monitor the charger or discharge as the case may be. If not, the CPU loops from step 242 to a step 244 in which it updates the timer 101. Until the timer times out as noted in step 245, step 245 leads back to step 242 in which the CPU reads the output of A/D converter 31 to determine if current is flowing. Thus, if no current flows for the duration of the timer, for example, one hour, then step 245 leads back to step 202 in which the CPU starts timer 62 and enters again into the light-sleep mode. As noted above, this conserves power because most of the power to the CPU is turned off until the interrupt pulse is generated at interrupt port 83 in step 204. This begins another iteration of the flow chart.

FIGURE 4 illustrates one type of design for the amplifier 22. According to this design, the amplifier is a switching type and includes associated circuitry as follows. One side of resistor 20 is connected to a positive input of an amplifier 222 via a switch 150 and a series capacitor 152. The other side of resistor 20 is connected to the same input of amplifier 122 via a switch 156 and the capacitor 152. The output of amplifier 222 is supplied through another series capacitor 158 to the switch 23 en route to buffer 25 and the A/D converter of the CPU. To calibrate the amplifier 222, the CPU directs the selection decoder 61 to transmit a binary 1 calibrate pulse ("CAL") to the input of inverter gate 161 and a binary 1 pulse to AND gate 73. Consequently, a binary zero pulse is sent to the inputs of NAND gate 160 and AND gate 164, and switch 156 is opened and switch 150 is closed. A square wave clock 168 supplies the other inputs of NAND gate 160, AND gate 164, and an input 151 of AND gate 73. Consequently, a reference voltage of the battery pack is supplied through switch 150 to a first side of capacitor 152. The other side of capacitor 152 is connected between resistors 170 and 172 which are identical to each other. The resistor 172 is connected to V_{∞} so that a zero current reference voltage of $V_{\infty}/2$ is supplied to the positive input of amplifier 222. Resistors 176 and 178 are identical to the re-

sistors 170 and 172 and similarly center the output voltage provided by amplifier 222 through capacitor 158. Resistors 170, 172, 176 and 178 are provided to center the zero current so that the A/D converter can indicate both positive and negative voltages associated with charging and discharging current. Then, when the clock outputs a positive pulse to input 151 of gate 73, switch 23 supplies the reference voltage to A/D converter 36 via buffer 25. The CPU reads and stores the reference voltage.

It should also be noted that amplifier 222 is capable of two voltage gain ranges. When a transistor 180 is deactivated by a binary zero signal from port 182 of the CPU, the amplifier provides relatively low gain because a resistor 184 receives all the feed back current. However, when a binary 1 signal is supplied from port 182, the amplifier provides the relatively high gain because resistor 184 is in parallel with a resistor 186. Capacitor 188 ensures that amplifier 22 amplifies only AC signals. The CPU selects the gain to best utilize the range of the amplifier and A/D converter.

Next, the CPU directs the selection decoder 61 to deliver a binary 1 signal to NAND gate 160 and AND gate 164 by transmitting a binary zero pulse to inverter gate 161 so that the voltages at each end of resistor 20 are sequentially supplied to the first side of capacitor 152 and the resultant, centered voltages are applied to the positive input of amplifier 222. The output of amplifier 222 is smoothed by a capacitor 29 (FIGURE 2) and indicates the voltage across resistor 20 due to either charge or discharge of the battery cells. The voltage is read by the CPU at the output of the A/D converter.

By the foregoing, a battery charging system comprising a battery pack and an associated battery charger embodying the present invention has been disclosed. However, numerous modifications and substitutions may be made without deviating from the scope of the invention. For example, if desired, a non-switching amplifier may be utilized for amplifier 22. Therefore, the invention has been disclosed by way of illustration and not limitation, and reference should be made to the following claims to determine the scope of the invention.

Claims

1. A battery pack (10) including :
 - a plurality of battery cells (12) ;
 - positive and negative terminals (14,16)
 - serially coupled to said battery cells (12) ;
 - sensing means (20) for sensing current flowing through said battery cells (12) and said positive and negative terminals (14, 16) ;
 - memory means (60) for storing battery parameter data and electronic means (28) cou-

pled to said sensing means (20) and said memory means (60) ;

said battery pack being characterized in that :

- a) an output port (124) outputs data from said battery pack (10) in response to external coupling of one or more current pulses (102) to said positive terminal (14) in the direction of charging current ;
- b) said sensing means (20) detects said current pulses (102) externally coupled to said terminal (14) in the direction of charging current ; and
- c) said electronic means (28) transmits said battery parameter data to said output port (124) in response to sensing by said sensing means (20) of said one or more current pulses (102) externally coupled to said positive terminal (14).

2. A battery pack (10) according to claim 1, characterized in that the sensing means comprises a resistor (20) in series with said positive and negative terminals (14,16) and said battery cells (12), and an amplifier (22) coupled to the series resistor (20) to measure the voltage across said series resistor (20), the output of said amplifier (22) being coupled to said electronic means (28).

3. A battery pack (10) according to claim 2, characterized in that the sensing means (20) further comprises a comparator (70) having a first input connected to the output of said amplifier (22), a second input connected to a source of threshold voltage, and an output connected to said electronic means (28), whereby said electronic means (28) receives a binary signal corresponding to said data current ; and said electronic means (28) includes means (31) for reading said binary signal.

4. A battery pack (10) according to claim 1, characterized in that its positive and negative terminals (14,16) are releasibly coupled to a battery charger (11) for delivering substantial charging current and the data current to said positive terminal and battery cells (12).

5. A battery pack (10) according to claim 4, characterized in that said battery charger (11) further comprises means (94,96) coupled to said output port (124) of said battery pack for reading and processing said battery parameter data, and controlling the charge current delivery means (92) in accordance with said battery parameter data.

6. A battery pack (10) according to claim 1, characterized in that said battery parameter data describes the state of charge of said battery cells

(12).

7. A battery pack (10) according to claim 1, characterized in that the electronic means further comprises :

a) processor means (28) coupled to the sensing means (20) , powered by said battery cells (12) and functional in a relatively high power consumption mode to determine the state of charge of said battery cells (12) based on the amount of current flowing through said battery cells (12) ;

b) first means (62) for rendering said processor means (28) into the functional, relatively high power consumption mode at times to monitor the amount of current flow and determine the state of charge of said battery cells (12), and

c) second means (68) for automatically rendering said processor means (28) into a non-functional relatively low power consumption mode at other times to conserve power.

8. A battery pack (10) as set forth in claim 7 characterized in that flow of current is due to discharge of said battery cells (12), and said processor means (28) determines the state of charge based at least in part on the amount of ampere-hours of the discharge current.

9. A battery pack (10) as set forth in claim 7, characterized in that said flow of current is due to charging of said battery cells (12), and said processor means (28) determines the state of charge based at least in part on the amount of ampere-hours of the charge current.

10. A battery pack (10) as set forth in claim 7 characterized in that said second rendering means (68) renders said processor means (28) into said relatively low power consumption mode when said current does not flow through said battery pack for a predetermined period.

11. A battery pack (10) as set forth in claim 7 characterized in that the first rendering means comprises a timer (62) which periodically renders said processor means functional.

12. A battery pack (10) as set forth in claim 7 characterized in that said first rendering means (62) is coupled to the sensing means (20) and responsive to current flowing through said battery cells (12) to render said processor means (28) into said functional mode.

13. A battery pack (10) as set forth in claim 12 characterized in that said first rendering means (62)

is responsive to either charging or discharging current flowing through said battery cells to render said processor means into said functional mode.

14. A battery pack (10) as set forth in claim 13 characterized in that :

the sensing means includes a resistor (20) in series with said battery cells (12) and said positive and negative terminals (14,16) of said battery pack, and an amplifier (22) coupled to said resistor (20) to measure the voltage developed across said resistor (20) by said flow of current, the output of said amplifier (22) being coupled to an input of said first rendering means (62).

15. A battery pack (10) as set forth in claim 7 characterized in that it further comprises third means for rendering said microprocessor means (28) into a still lower power consumption mode when the voltage of said battery cells falls below a predetermined level.

16. A battery pack (10) as set forth in claim 7 characterized in that said second rendering means comprises a timer (62).

17. A battery pack (10) as set forth in claim 7 characterized in that said processor means (28) when functional also monitors battery temperature.

18. A battery pack (10) as set forth in claim 14 characterized in that said processor means (28) is programmed to read current data pulses transmitted into said positive terminal (14), and transmit data indicating the state of charge of said battery cells in response thereto.

Patentansprüche

1. Ein Batteriesatz (10) mit:
 einer Vielzahl von Batteriezellen (12);
 positiven und negativen in Reihe mit den Batteriezellen (12) verschalteten Anschlüssen (14, 16);
 einer Abtasteinrichtung (20) zum Abtasten eines durch die Batteriezellen (12) und die positiven und negativen Anschlüsse (14, 16) fließenden Stromes;
 einer Speichereinrichtung (60) zum Speichern von Batterieparameterdaten und einer elektronischen Einrichtung (28), welche mit der Abtasteinrichtung (20) und der Speichereinrichtung (60) verschaltet ist;
 dadurch gekennzeichnet,
 daß
 a) ein Ausgabeknoten (124) Daten von dem

- Batteriesatz (10) in Abhängigkeit einer externen Ankopplung eines oder mehrerer Stromimpulse (102) zu dem positiven Anschluß (14) in Richtung eines Ladestroms abgibt;
 b) die Abtasteinrichtung (20) die Stromimpulse (102) erfaßt, welche am Anschluß (14) in Richtung des Ladestroms extern angekoppelt sind; und
 c) die elektronische Einrichtung (28) die Batterieparameterdaten zum Ausgabeknoten (124) in Abhängigkeit zur Abtastung der Abtasteinrichtung (200) des einen oder der mehreren Stromimpulse (102) überträgt, welche Impulse extern an dem positiven Anschluß (14) angekoppelt sind.
2. Ein Batteriesatz (10) nach Anspruch 1, **dadurch gekennzeichnet**, daß die Abtasteinrichtung einen in Reihe mit positiven und negativen Anschlüssen (14, 16) und den Batteriezellen (12) verschalteten Widerstand (20) aufweist und ein Verstärker (22) mit dem Reihenwiderstand (20) zur Messung einer über dem Reihenwiderstand (20) abfallenden Spannung verschaltet ist, wobei die Ausgabe des Verstärkers (22) mit der elektronischen Einrichtung (28) gekoppelt ist.
3. Batteriesatz (10) nach Anspruch 2, **dadurch gekennzeichnet**, daß die Abtasteinrichtung (20) weiterhin einen Komparator (70) aufweist, welcher mit einem ersten Eingang mit dem Ausgang des Verstärkers (22), mit einem zweiten Eingang mit einer Schwellwertspannungsquelle und mit einem Ausgang mit der elektronischen Einrichtung (28) verschaltet ist, wobei die elektronische Einrichtung (28) ein Binärsignal entsprechend zum Datenstrom empfängt und eine Einrichtung (31) zum Lesen des Binärsignals aufweist.
4. Batteriesatz (10) nach Anspruch 1, **dadurch gekennzeichnet**, daß die positiven und negativen Anschlüsse (14, 16) lösbar mit einem Batterieladegerät (11) zur Zuführung eines substantiellen Ladestroms und des Datenstroms zum positiven Anschluß und den Batteriezellen (12) gekoppelt ist.
5. Batteriesatz (10) nach Anspruch 4, **dadurch gekennzeichnet**, daß das Batterieladegerät (11) weiter eine Einrichtung (94, 96) aufweist, welche mit dem Ausgabeknoten (124) des Batteriesatzes zum Lesen und Verarbeiten der Batterieparameterdaten und zur Steuerung der Ladestromzufuhreinrichtung (92) entsprechend zu den Batterieparameterdaten verschaltet ist.
6. Batteriesatz (10) nach Anspruch 1, **dadurch gekennzeichnet**, daß die Batterieparameterdaten den Ladungszustand der Batteriezellen (12) darstellen.
7. Batteriesatz (10) nach Anspruch 1, **dadurch gekennzeichnet**, daß die elektronische Einrichtung weiterhin aufweist:
 a) eine Verarbeitungseinrichtung (28), welche mit der Abtasteinrichtung (20) verschaltet ist und durch die Batteriezellen (12) betrieben und funktionsfähig in einem relativ hohen Leistungsaufnahmemodus ist, um den Ladungszustand der Batteriezellen (12) auf der Grundlage des durch die Batteriezellen (12) fließenden Stromwertes zu bestimmen;
 b) eine erste Einrichtung (62) zum Verstellen der Verarbeitungseinrichtung (28) in ihren funktionsfähigen, relativ hohen Leistungsaufnahmemodus zu Zeiten, in denen der Stromflußwert überwacht und der Ladungszustand der Batteriezellen (12) bestimmt wird, und
 c) eine zweite Einrichtung (68) zum automatischen Stellen der Verarbeitungseinrichtung (28) in ihren nichtfunktionsfähigen, relativ niedrigen Leistungsaufnahmemodus zur Energieeinsparung zu anderen Zeiten.
8. Batteriesatz (10) nach Anspruch 7, **dadurch gekennzeichnet**, daß der Stromfluß aufgrund einer Entladung der Batteriezellen (12) erfolgt und die Verarbeitungseinrichtung (28) den Ladungszustand auf Grundlage zumindest zum Teil eines Betrags von Amperestunden des Entladungsstroms bestimmt.
9. Batteriesatz (10) nach Anspruch 7, **dadurch gekennzeichnet**, daß der Stromfluß durch ein Laden der Batteriezellen (12) hervorgerufen ist und die Verarbeitungseinrichtung (28) den Ladungszustand auf der Grundlage zumindest zum Teil eines Betrages von Amperestunden des Ladestroms bestimmt.
10. Batteriesatz (10) nach Anspruch 7, **dadurch gekennzeichnet**, daß die zweite Stelleinrichtung (68) die Verarbeitungseinrichtungen (28) in den relativ niedrigen Leistungsverbrauchsmodus verstellt, wenn Strom für weniger als eine vorbestimmte Zeitdauer durch den Batteriesatz fließt.
11. Batteriesatz (10) nach Anspruch 7, **dadurch gekennzeichnet**, daß die erste Stelleinrichtung einen Zeitgeber (62) aufweist, welcher periodisch die Verarbei-

tungseinrichtung funktionsfähig schaltet.

12. Batteriesatz (10) nach Anspruch 7,
dadurch gekennzeichnet,
daß die erste Stelleinrichtung (62) mit der Abtasteinrichtung (20) verschaltet ist und in Abhängigkeit zu einem durch die Batteriezellen (12) fließenden Strom die Verarbeitungseinrichtung (28) in ihren funktionsfähigen Modus schaltet. 5
13. Batteriesatz (10) nach Anspruch 12,
dadurch gekennzeichnet,
daß die erste Stelleinrichtung (62) in Abhängigkeit entweder vom Lade- oder Entladestrom, welcher durch die Batteriezellen fließt, die Verarbeitungseinrichtung in ihren funktionsfähigen Modus schaltet. 10
14. Batteriesatz (10) nach Anspruch 13,
dadurch gekennzeichnet,
daß die Abtasteinrichtung einen in Reihe mit den Batteriezellen (12) und den positiven und negativen Anschlüssen (14, 16) des Batteriesatzes verschalteten Widerstand (20) aufweist und ein Verstärker (22) zur Messung einer über den Widerstand durch den Stromfluß abfallenden Spannung mit dem Widerstand (20) verschaltet ist, wobei der Ausgang des Verstärkers (22) mit dem Eingang der ersten Stelleinrichtung (22) verschaltet ist. 15
15. Batteriesatz (10) nach Anspruch 7,
dadurch gekennzeichnet,
daß dieser eine dritte Einrichtung zum Stellen eines Mikroprozessors (28) in einen Modus mit noch geringerer Leistungsaufnahme aufweist, wenn die Spannung der Batteriezellen unter einen vorbestimmten Pegel fällt. 20
16. Batteriesatz (10) nach Anspruch 7,
dadurch gekennzeichnet,
daß die zweite Stelleinrichtung einen Zeitgeber (62) aufweist. 25
17. Batteriesatz (10) nach Anspruch 7,
dadurch gekennzeichnet,
daß die Verarbeitungseinrichtung (28) bei Funktionsfähigkeit die Batterietemperatur überwacht. 30
18. Batteriesatz (10) nach Anspruch 14,
dadurch gekennzeichnet,
daß die Verarbeitungseinrichtung (28) zum Lesen von Stromdatenimpulsen programmiert ist, welche zum positiven Anschluß (14) übertragen werden und welche in Abhängigkeit davon Daten überträgt, welche den Ladungszustand der Batteriezellen anzeigen. 35

Revendications

1. Ensemble de batterie (10) comprenant:
une pluralité d'éléments de batterie (12);
des bornes positive et négative (14, 16)
couplées en série auxdits éléments de batterie (12);
des moyens de détection (20) pour détecter un courant passant dans lesdits éléments de batterie (12) et lesdites bornes positive et négative (14, 16);
des moyens de mémorisation (60) pour stocker des données de paramètre de batterie et des moyens électroniques (28) couplés auxdits moyens de détection (20) et auxdits moyens de mémorisation (60);
ledit ensemble de batterie étant caractérisé en ce que:
a) un port de sortie (124) envoie des données depuis ledit ensemble de batterie (10), en réponse à un couplage extérieur d'une ou plusieurs impulsions de courant (102), à ladite borne positive (14), dans la direction du courant de charge;
b) lesdits moyens de détection (20) détectent lesdites impulsions de courant (102) couplées extérieurement à ladite borne (14), dans la direction du courant de charge; et
c) lesdits moyens électroniques (28) transmettent lesdites données de paramètre de batterie audit port de sortie (124), en réponse à une détection effectuée par lesdits moyens de détection (20) de ladite ou desdites impulsions de courant (102) couplées extérieurement à ladite borne positive (14). 40
2. Ensemble de batterie (10) selon la revendication 1, caractérisé en ce que les moyens de détection comprennent une résistance (20) en série avec lesdites bornes positive et négative (14, 16) et lesdits éléments de batterie (12), et un amplificateur (22) couplé à la résistance série (20) pour mesurer la tension aux bornes de ladite résistance série (20), la sortie dudit amplificateur (22) étant couplée auxdits moyens électroniques (28). 45
3. Ensemble de batterie (10) selon la revendication 2, caractérisé en ce que les moyens de détection (20) comprennent en outre un comparateur (70) ayant une première entrée connectée à la sortie dudit amplificateur (22), une deuxième entrée connectée à une source de tension seuil, et une sortie connectée auxdits moyens électroniques (28), de manière que lesdits moyens électroniques (28) reçoivent un signal binaire correspondant audit courant de données; et lesdits moyens électroniques (28) comprennent des 50

moyens (31) pour lire ledit signal binaire.

4. Ensemble de batterie (10) selon la revendication 1, caractérisé en ce que ses bornes positive et négative (14, 16) sont couplées de manière amovible à un chargeur de batterie (11), pour fournir un courant de charge substantiel et le courant de données à ladite borne positive et auxdits éléments de batterie (12). 5
5. Ensemble de batterie (10) selon la revendication 4, caractérisé en ce que ledit chargeur de batterie (11) comprend en outre des moyens (94, 96) couplés audit port de sortie (124) dudit ensemble de batterie, pour lire et traiter lesdites données de paramètre de batterie, et commander les moyens d'émission de courant de charge (92) en fonction desdites données de paramètre de batterie. 10
6. Ensemble de batterie (10) selon la revendication 1, caractérisé en ce que lesdites données de paramètre décrivent l'état de charge desdits éléments de batterie (12). 15
7. Ensemble de batterie (10) selon la revendication 1, caractérisé en ce que les moyens électroniques comprennent en outre : 20
 - a) des moyens de traitement (28) couplés auxdits moyens de détection (20), alimentés par lesdits éléments de batterie (12) et fonctionnant dans un mode de consommation de puissance relativement élevée pour déterminer l'état de charge desdits éléments de batterie (12) sur la base de la quantité de courant passant dans lesdits éléments de batterie (12); 25
 - b) des premiers moyens (62) pour faire passer lesdits moyens de traitement (28) en mode fonctionnel, de consommation de puissance relativement élevée à des moments servant à surveiller la quantité d'écoulement de courant et à déterminer l'état de charge desdits éléments de batterie (12), et 30
 - c) des seconds moyens (68) pour faire passer automatiquement lesdits moyens de traitement (28) en un mode de non fonctionnement, à consommation de puissance relativement faible, à d'autres moments, pour conserver la puissance. 35
8. Ensemble de batterie (10) selon la revendication 7, caractérisé en ce que l'écoulement de courant est imputable à une décharge desdits éléments de batterie (12), et lesdits moyens de traitement (28) déterminent l'état de charge sur la base au moins en partie de la quantité d'Ampères-heures du courant de décharge. 40

9. Ensemble de batterie (10) selon la revendication 7, caractérisé en ce que ledit écoulement de courant est imputable à un chargement desdits éléments de batterie (12), et lesdits moyens de traitement (28) déterminent l'état de charge sur la base au moins en partie de la quantité d'Ampères-heures du courant de charge. 45
10. Ensemble de batterie (10) selon la revendication 7, caractérisé en ce que lesdits seconds moyens de commutation (68) font passer lesdits moyens de traitement (28) dans ledit mode de consommation de puissance relativement faible, lorsque ledit courant ne passe pas dans ledit ensemble de batterie pendant une période prédéterminée. 50
11. Ensemble de batterie (10) selon la revendication 7, caractérisé en ce que les premiers moyens de commutation comprennent un temporisateur (62) qui rend périodiquement fonctionnel lesdits moyens de traitement. 55
12. Ensemble de batterie (10) selon la revendication 7, caractérisé en ce que lesdits premiers moyens de commutation (62) sont couplés aux moyens de détection (20) et sont sensibles à un courant passant dans lesdits éléments de batterie (12), pour faire passer lesdits moyens de traitement (28) dans ledit mode fonctionnel.
13. Ensemble de batterie (10) selon la revendication 12, caractérisé en ce que lesdits premiers moyens de commutation (62) sont sensibles à un courant de charge ou de décharge passant dans lesdits éléments de batterie, pour faire passer lesdits moyens de traitement dans ledit mode fonctionnel.
14. Ensemble de batterie (10) selon la revendication 13, caractérisé en ce que: 60

les moyens de détection comprennent une résistance (20) en série avec lesdits éléments de batterie (12) et lesdites bornes positive et négative (14, 16) dudit ensemble de batterie, et un amplificateur (22) couplé à ladite résistance (20) pour mesurer la tension se développant aux bornes de ladite résistance (20), sous l'effet dudit écoulement de courant, la sortie dudit amplificateur (22) étant couplée à une entrée desdits premiers moyens de commutation (62).
15. Ensemble de batterie (10) selon la revendication 7, caractérisé en ce qu'il comprend en outre des troisièmes moyens pour faire passer lesdits moyens à microprocesseur (28) dans un mode de consommation de puissance encore plus faible, lorsque la tension de ledit ensemble de batterie chute à une valeur inférieure à un niveau prédé-

terminé.

16. Ensemble de batterie (10) selon la revendication 7, caractérisé en ce que lesdits seconds moyens de commutation comprennent un temporisateur (62). 5
17. Ensemble de batterie (10) selon la revendication 7, caractérisé en ce que lesdits moyens de traitement (28), lorsqu'ils sont fonctionnels, surveillent également la température de la batterie. 10
18. Ensemble de batterie (10) selon la revendication 14, caractérisé en ce que lesdits moyens de traitement (28) sont programmés pour lire des impulsions de données de courant transmises à ladite borne positive (14) et transmettre des données indiquant l'état de charge desdits éléments de batterie, en réponse à ces dernières. 15

20

25

30

35

40

45

50

55

11

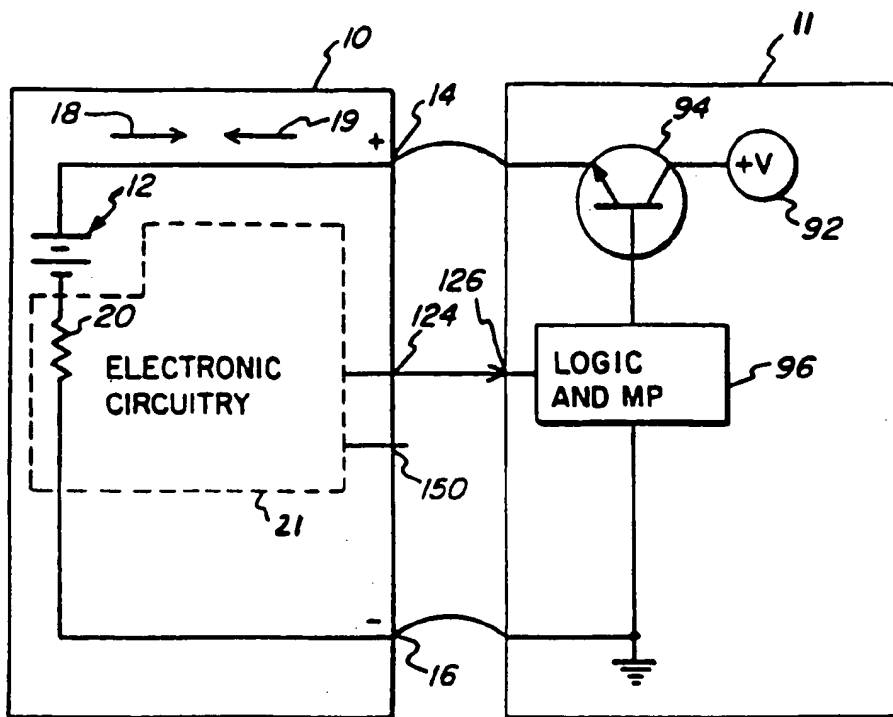


FIG. 1

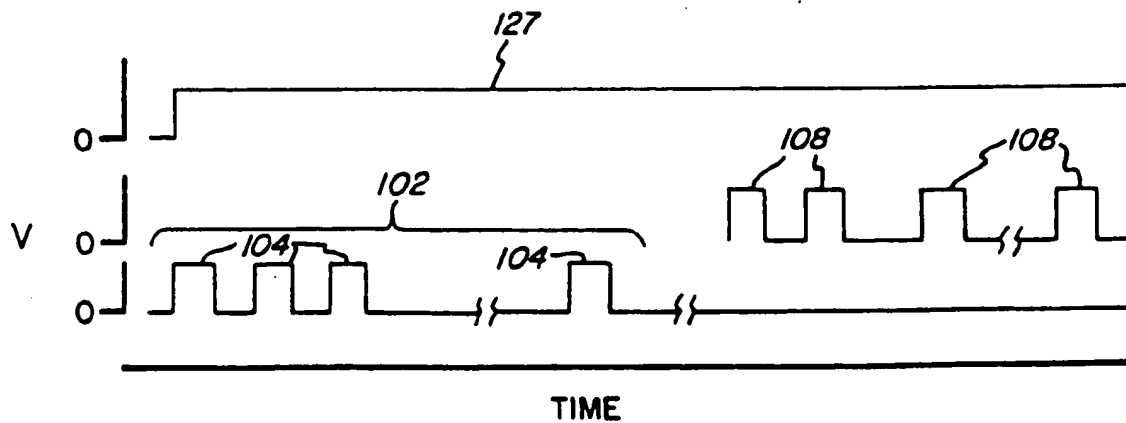


FIG. 3

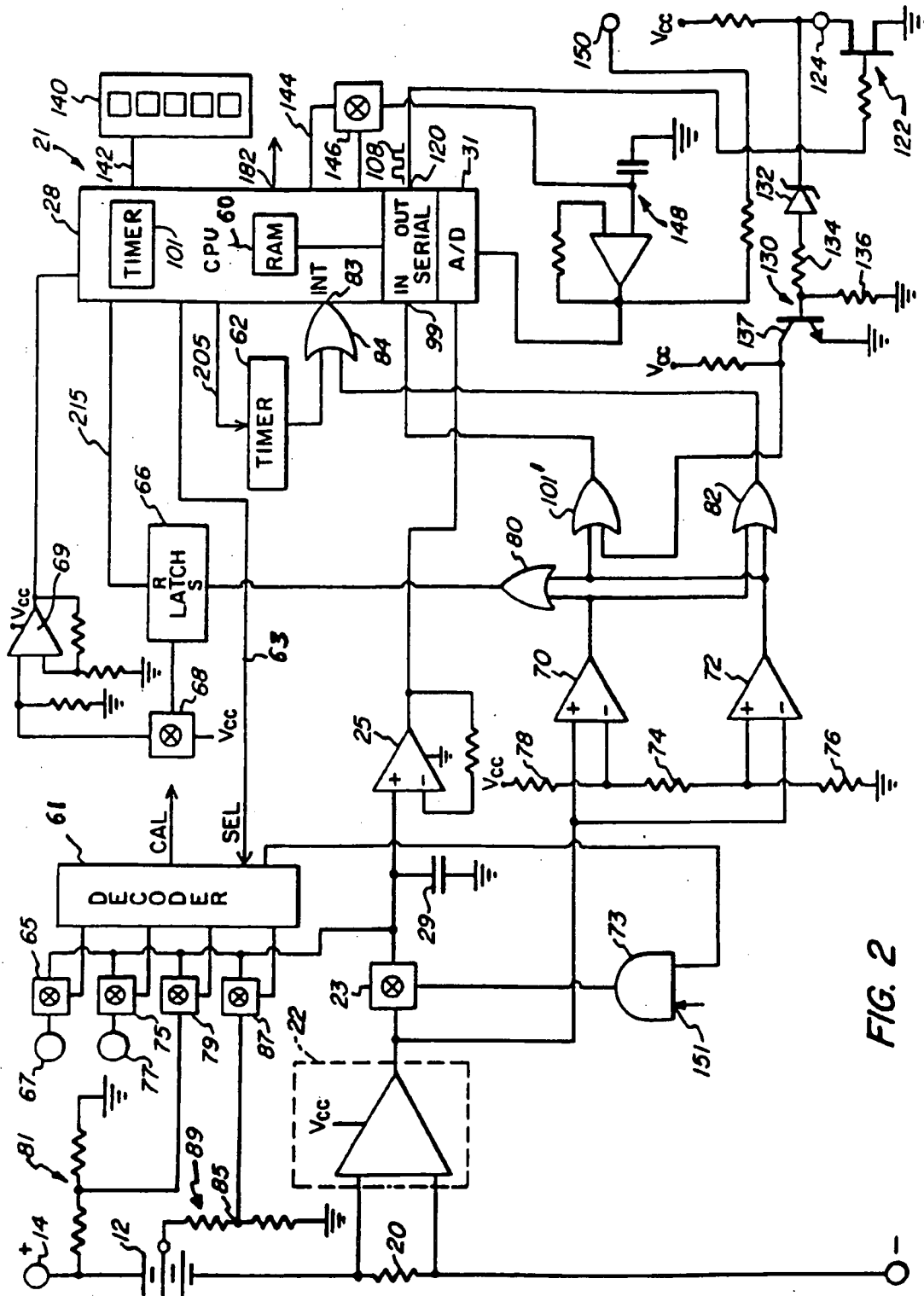


FIG. 2

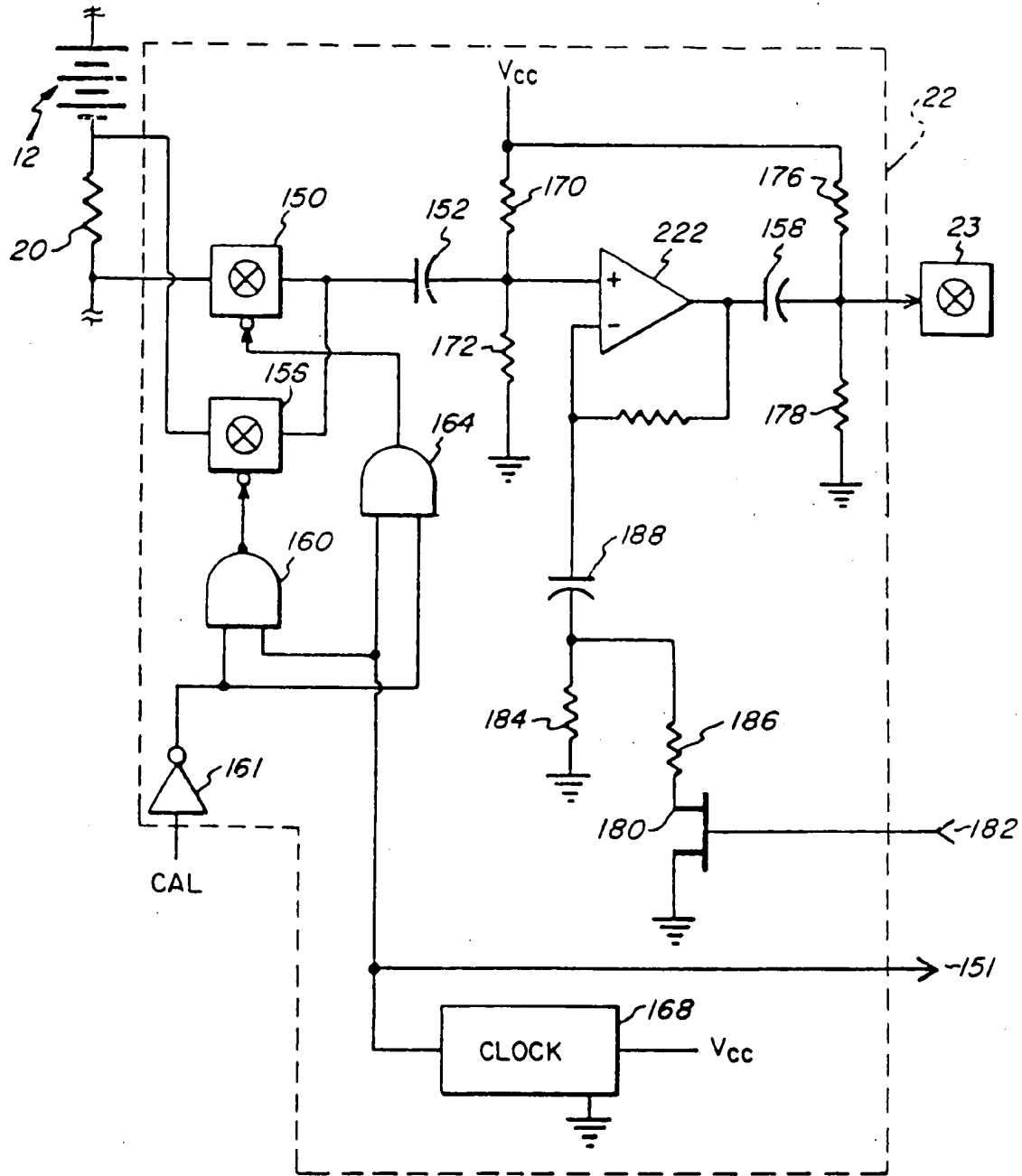


FIG. 4

